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The Effect of Traditional Transportation Using Cool Box on Quality of Fresh Milk and Frozen Milk from Peternakan Sapi Terpadu Sangatta to Samarinda East Kalimantan

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ABSTRACT

This study was aimed to determine the quality of milk before and after through the transportation process as far as ± 180 km for ± 4 hours from Peternakan Sapi Terpadu, North Sangata to Samarinda. This research used 2 treatments: frozen and fresh milk. Preliminary tests carried out before the transport process, while the final tests carried out after transportation including parameters of chemical composition, physical quality and organoleptic quality. Data were analyzed by statistic t-test. The results showed that the physical, chemical and organoleptic attributes (except viscosity) of frozen and fresh milk were not significantly different before and after transportation. The viscosity of frozen milk before and after transportation were 1.0212 and 1.0277 g/cm3 respectively, while on fresh milk were 1.0265 and 1.0272 g/cm3, respectively. The freezing point of milk before and after transportation was -0.445 to -0.527ºC for frozen milk and -0.480 ºC to 0.490ºC for fresh milk. Protein content before and after transportation was 2.52% to2.78% for frozen milk and from 2.78 % to 2.87% for fresh milk. The fat content before and after transportation was 6.78% to 5.04% for frozen milk and from 3.73% to 4.04% for fresh milk. The lactose content before and after transportation that is from 13.66% become 13.21% for frozen milk and 11.33% to 11.88% for fresh milk. The total solid content before and after transportation was 13.66 % and 13.21% for frozen milk and 11.33% to 11.88% for fresh milk. The SNF content before and after transportation was 6.88 % to 8.17 % for frozen milk and from 7.60% to 7.84% for fresh milk. It can be concluded that traditional transportation of milk from Peternakan Sapi Terpadu to Samarinda did not affect the organoleptic, physical, and chemical except viscosity of milk.

Keywords: Fresh milk, Frozen milk, Quality of PFH cow milk, Traditional transportation

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Introduction

Milk contains nutritional needs, functional and physiological value to maintain the human body. Nutritional value of milk is based on macro and micronutrient for a healthy life. Nutrient from milk includes proteins and peptides with complete range on all essential amino acids. Milk and dairy products also provide a number of physiological properties: fat and the presence of saturated fatty acids and some unsaturated fatty acids, which indicate an important role in physiological regulation, such as Conjugated Linoleic Acid (CLA), lactose and some minor oligosaccharides; major minerals such as calcium, magnesium and also phosphorus and vitamins (Kanekanian, 2014).

The production of fresh milk in Indonesia, particularly in East Kalimantan is still low. From 2014 to 2016, East Kalimantan produced 118 ton, 121 ton and 179 ton of milk each year respectively. Milk production in East Kalimantan comes from 4 cattle farm, one of them is Peternakan Sapi Terpadu (PESAT) in quarry location at PT. Kaltim Prima Coal (KPC). Peternakan Sapi Terpadu is well-known as PESAT. PESAT is located in North Sangatta, East Kutai regency. It can produce 70 liters of milk each day. They distribute the milk to several areas including Samarinda, the capital city of East Kalimantan. The distance from PESAT to Samarinda is around 180 km and can be reached for 4 hours. During transportation, milk damage can occur. Motarjemi *et al.* (2014) found that milk collection and transportation is one of the points in the food chain which allows contamination of milk by chemicals or microbial contamination and growth of microorganisms. Milk should be stored at 60°C or below and must be processed as quickly as possible, to minimize the growth of microorganisms. Murti *et al.* (2009) explained that milk transportation is expected to be as low as possible to reduce shocks movement during transportation which can lead to the decrease of milk quality. Mortensen (2010) also stated that fat content on milk is formed as a fat globule with a nucleus of triacylglyceride coated by 2 layers, phospholipid and membrane protein (milk fat globule membrane = MFGM). Lipoprotein lipase (LPL) enzyme can hydrolyze most of the triacylglycerides. However, the enzyme can only work when the MFGM layer is disrupted. When milk fat has mechanical damage such as agitation, fertilization or homogenization, which might be occur during transportation, the membrane will be broken, and LPL will affect the triacylglycerides. This research was conducted to determine the quality of milk before and after transportation from Peternakan Sapi Terpadu (PESAT) Sangatta Utara to Samarinda.

Materials and Methods

Materials

Materials on this research were cooler box, polyethylene plastic, tubes, Erlenmeyer, pH meter (TOA), lactose can type MCC50, titration set, and water bath. Fresh milk was used as the sample while ice, alcohol 70%, phenolphthalein indicator, NaOH 0.25 N and methylene blue were prepared for chemical analysis.

Method

Sample collection. Milk samples were collected from PESAT, North Sangatta. For frozen milk, 1 litre of milk was taken from morning milking and kept in the bottle at -5^{0}C overnight. Fresh milk was taken on the next day with the same amount. Milk was packaged in polyethylene for further analysis.

Initial test. The initial test was conducted at PESAT include organoleptic test (color, flavor, aroma, and viscosity), physical test (alcohol test and pH test) and chemical test (protein, fat, lactose, total solids, solid non fat (SNF), density, the freezing point of milk). The chemical test was done using lactoscan.

Transportation. Fresh milk and frozen milk samples were stored in a cooling box added with ice cubes at temperature ±4°C. The milk was distributed using a motor vehicle from Sangatta Utara to Samarinda. The distance was about ± 180 km and took time about ± 4 hours.

Final test. The final test was conducted at the Laboratory of Animal Production and Technology, and the Laboratory of Agriculture Chemistry and Biochemistry, Faculty of Agriculture, Mulawarman University with the same parameters as the initial test.

Organoleptic test. Panellists for this research were employees of PT Kaltim Prima Coal, students, and staff of the Faculty of Agriculture Mulawarman University. Recruitment, selection, and training were conducted according to sensory evaluation procedures (Murray *et al*., 2001). Twenty-five panellists were selected from 30 potential panellists. Milk was poured in a small glass and served to the panellist. This test consists of color, viscosity, aroma, and taste of milk. The score for the organoleptic test as follows: color (1 to 5 for white blue to golden yellow), viscosity (1 to 5 for very thick to very watery), aroma (1 to 5 for milk aroma to other fragrance), flavor (1 to 5 for radish to bitter flavor).

Measurement of pH and alcohol. pH and alcohol values are the important parameters to determine milk quality. This measurement was performed using a pH meter which has been calibrated at buffer solution pH 6.86 and pH 4.01. The alcohol test was done according to SNI 01-2782-1998 (Badan Standarisasi Nasional, 1998).

Analysis of chemical composition. Analysis of chemical composition (protein, fat, lactose, total solids, solid nonfat (SNF), density, and freezing point) was done using lactoscan. Calibration was performed before analysis using a cleaning base solution with temperature ranging from 50 to 60°C. The alkaline solution was placed at the sample site on the lactose can, then starts the cleaning on the main menu, after that lactose can be recalibrated using distilled water. About 20 ml of milk was poured into a glass; the lactose can was turned on, a fresh milk sample was placed in sample preparation, then the sample was analyzed.

Data analysis. Data analysis of alcohol, pH value, and chemical composition (protein, fat, lactose, total solids, solids nonfat viscosity and freezing point of milk) was analyzed using statistic Paired T-test. Organoleptic was analyzed using Kruskal Wallis using SPSS 24.

Result and Discussion

Organoleptic test

Color test. Data of organoleptic test on a color test of fresh and frozen milk before and after transportation from Sangata to Samarinda (Table 1) showed no significant difference (P>0,05). Milk color of organoleptic test result was similar to the color of normal milk; it was ranging from bluish white to golden yellow (Sugiyono *et al*., 2011). White color on milk is formed by the white color of casein. Casein is a colloidal dispersion and translucent (Diastri and Agustina, 2013). The yellow color on milk is caused by fat-soluble carotene pigment which comes from forage feed, and water-soluble riboflavin pigment that gives yellowish color on whey (Mirdhayati *et al*., 2008). Knockaert *et al*., (2015) explained that carotene is a hydrocarbon compound contained in milk in small quantities. Carotene has contributed 10 to 15% vitamin A, and it was responsible for the formation of yellow color on fat milk. Color is one of the important parameters in milk. During the transportation process from Sangata to Samarinda, there was no change in the nutritional content of fresh milk, so that no color changed in milk. The was due to the absence of additional ingredients.

The consistency of milk. The significant differences (P <0.05) of frozen milk before and after transportation was given in Table 1. The consistency of frozen milk was changed from viscous to liquid and fresh milk either. Factors that affect the consistency of milk are protein and fat milk concentration (Kumalasari *et al*., 2012). Goof (2010) also stated that shocking movement during transportation caused agglutination of fat globules and decreased milk consistency. The consistency of milk will increase when acidification occurs, increased bacterial growth and changes in milk proteins, particularly casein which is hydrophilic as well as other proteins (Sugiyono *et al*., 2011). Mortensen (2010) also observed that lipoprotein lipase (LPL) enzyme could hydrolyze most of the triacylglyceride which is the core of fat globules when the fat globule membrane (MFGM) protector have mechanic damage due to agitation, fertilization or homogenization. Changes in the consistency of milk from viscous to liquid are considered as normal conditions. According to Diastri and Agustina (2013), the normal viscosity of milk is liquid.

Milk flavor. The results showed no significant difference (P> 0.05) of milk both in fresh and frozen milk before and after transportation (Table 1). Flavor of fresh milk before and after transportation was normal. It was due to the absence of milk decomposition during and inhibition of bacterial growth during transportation. Kumalasari *et al*. (2012) explained that normal milk has a slightly cowy flavor which influenced by feed and decomposition of milk content. The astringent flavor on milk is caused by oxidation and hydrolysis reaction. (Buckle *et al*., 2008). Moreover, Mirdhayati *et al*. (2008) found that off-flavor on milk was due to the physical disturbance of cow, foreign materials, contamination with environmental air and decomposition of milk component with. It also can be caused by chemical reactions such as hydrolysis of glyceride which lead to the degradation of unsaturated fatty acids and make rancidity of milk (Sugiyono *et al*., 2011).

Milk taste. The results showed either frozen milk and fresh milk before and after transportation (Table 1) were not significantly different (P> 0.05). Frozen milk and fresh milk before and after transportation had a slightly sweet taste. Normally, milk has a slightly sweet and salty taste. Sweet taste in milk is affected by the lactose contained in the milk (Kumalasari *et al*., 2012). While the salty taste in milk comes from chlorides, citrates, and other mineral salts. Sugiyono *et al*. (2011) explained that factors affect the taste of milk are feed, disease, bacterial contamination in milk, and post-harvest handling. Contamination of bacteria can be prevented by cooling treatment during transportation which might not change milk taste after transportation.

The physical quality of milk

pH value of milk. The pH value of frozen milk and fresh milk before and after transportation (Table 2) was calculated using the t-test and not significantly different (P> 0.05). The pH value of frozen milk and fresh milk before and after transportation was 6.8. The pH value of milk shows the magnitude of ion H+ concentration in milk that describes milk damage due to microbial growth. Dwitania and Swacita (2013) found pH values of milk were due to casein, buffer, phosphate and citrate, whereas pH changes in milk were caused by the conversion of lactose to lactic acid.

Alcohol test. The alcohol test was negative for either frozen milk and fresh milk before and after transportation. According to SNI 01-3141-2011, alcohol test of milk should be negative, so that the alcohol test of this research fulfilled the predefined standard. Moreover, Sugiyono *et al*. (2011) state that milk contains more than 0.21% of acid, calcium, and magnesium in high amount would be coagulated by the addition of alcohol in the milk alcohol test.

Table 1. Organoleptic quality frozen milk and fresh milk before and after transportation

Parameter	S1 Before	S2 before	S1 after	S2 after
Average color score	2.51	2.56	2.76	2.64
Average viscosity score	2.84^{a}	3.02^{b}	3.36^{c}	3.67^{d}
Average flavor score	2.16	2.62	2.13	2.47
Average taste score	1.96	2.22	2.36	2.02

S1= Frozen milk; S2 = Fresh milk
Organoleptic evaluation score: color (1 to 5, white bluish to golden yellow), viscosity (1 to 5, very thick to very fluid), flavor (1 to 5, cow's milk flavor to another flavor), taste (1 to 5, radish to bitter)
Note: Data continued by the same alphabet in the same column are not significantly different by t-test (P<0.05).

Table 2. pH value of frozen milk and fresh milk before and after transportation

Treatment	Replication			Average
	1	2	3	
S1 Before	6.7	6.9	6.7	6.8±0,1
S2 Before	6.7	6.9	6.8	6.8±0,1
S1 After	6.7	7.0	6.8	6.8±0,2
S2 After	6.8	6.9	6.7	6.8±0,1

S1 = Frozen milk; S2 = Fresh milk.

Table 3. Alcohol test of frozen milk and fresh milk before and after transportation

Treatment	Test Result
S1 before	Negative
S2 before	Negative
S1 after	Negative
S2 after	Negative

S1 = Frozen milk; S2 = Fresh milk.

The viscosity of Milk. Table 4 shows the viscosity of frozen milk and fresh milk before and after transportation was not significantly different (P>0.05). The viscosity of frozen milk before and after transportation was 1.0212 g/cm3 and 1.0277 g/cm3, respectively, while the fresh milk before and after transportation was 1.0265 g/cm3 and 1.0272 g/cm3, respectively. Jogensen and Hoffman (2008) *cit.* Soeparno (2015) observed that testing time might affect the value of viscosity, the earlier test time resulted in smaller value compared to give space-time 3 hours after milking, it was due to change in the fat content, and the presence of gas arise in milk. Yudonegoro *et al*. (2014) suggest that viscosity of milk would increase slowly from milking until the climax at 12 hours after milking, this increase was due to the release of gases such as CO2 and N2 contained in fresh milk. The Viscosity of milk also can be influenced by milk fat content (Sugiyono *et al*., 2011). Milk with low fat content has a low viscosity, and milk with high fat content has a high viscosity as well.

The freezing point of milk. Length transportation was not affected by the freezing point of frozen and fresh milk ($p<0.05$). According to Table 5, the freezing point of frozen milk and fresh milk before and after transportation showed no significant difference ($P>0.05$). The freezing point of frozen milk before and after transportation was -0.445°C and -0.527°C, whereas freezing point of frozen milk before and after transportation was -0.480°C and -0.498°C. The freezing point of frozen milk and fresh milk was not affected by transportation for ± 4 hours. Lampert (1975) *cit.* Soeparno (2015) observed that the nutritional status of cow and addition of water to milk could affect the freezing point of milk. Mukhtar (2006) found that freezing point was affected by feed, season, cattle and the addition of milk even only in small amount, such as coconut milk or fat. The chemical composition of milk, lactose, and minerals can also determine the freezing point of milk, so the freezing point of milk is lower than the freezing point of water (Sugiyono *et al*., 2011).

The chemical composition of milk

Protein content. The protein content of frozen milk and fresh milk before and after transportation was not significantly different ($P> 0.05$). The protein content of frozen milk before and after transportation was 2.51% and 2.99% respectively, while fresh milk before and after transportation was 2.78% and 2.87%, respectively. Sugiyono *et al*. (2011) explained that factors affecting milk proteins are a breed of cattle, feed, and lactation time. Mukhtar (2006) also observed that the percentage of protein increase during the fifth day of lactation and begin to decrease during the first two to three months of lactation, then increases again in line with the decreased milk production.

Fat content. Length transportation did not affect the fat content of frozen and fresh milk both before and after transportation ($p>0.05$). The fat content of frozen milk fat before and after transportation was 6.78% and 5.04%, respectively, while the fat content of fresh milk before and after transportation was 3.73% and 4.04%, respectively. Changes in the level of

Table 4. The viscosity of frozen and fresh milk before and after transportation

Replication	S1 before (g/cm^3)	S2 before (g/cm^3)	S1 after (g/cm^3)	S2 after (g/cm^3)
1	1.0205	1.0260	1.0279	1.0260
2	1.0220	1.0276	1.0327	1.0281
3	1.0211	1.0259	1.0224	1.0276
Average	1.0212±0.0007	1.0265±0.0009	1.0277±0.0051	1.0272±0.0011

S1 = Frozen milk; S2 = Fresh milk.

Table 5. Freezing point frozen milk and fresh milk before and after transportation

Replication	S1 Before (°C)	S2 before (°C)	S1 after (°C)	S2 after (°C)
1	-0.449	-0.475	-0.517	-0.478
2	-0.447	-0.499	-0.607	-0.511
3	-0.439	-0.465	-0.456	-0.506
Average	-0.445±0.005	-0.480±0.018	-0.527±0.076	-0.498±0.018

S1 = Frozen milk; S2 = Fresh milk.

Tabel 6. Chemical composition of frozen and fresh milk before and after transportation

Treatment	Protein (%)	Fat (%)	Lactose (%)	Total Solids (%)	SNF (%)
S1 Before	2.51±0.25	6.78±0.79	3.78±0.04	13.66±0.77	6.88±0.08
S2 Before	2.78±0.094	3.73±0.19	4.18±0.14	11.33±0.34	7.60±0.25
S1 After	2.99±0.42	5.04±1.09	4.49±0.62	13.21±0.72	8.17±1.14
S2 After	2.87±0.096	4.04±0.12	4.31±0.15	11.88±0.21	7.84±0.26

S1 = Frozen milk; S2 = Fresh milk.

fat content were probably due to the friction between fat globule that caused by shocking movement during transportation (Goof, 2010). Milk fat destruction can cause a variety of deviant flavors in dairy products (Buckle *et al*., 2008). The content of milk fat is influenced by feed because most of the milk component is synthesized in udder from small substrate derived from the feed (Mirdhayati *et al*., 2008). Milk fat content can also be influenced by the genetics of cattle, climate, lactation time, the age of cattle, feed nutrition and milking time (Soeparno, 2015).

Lactose. Frozen milk contains 3.78% and 4.49% of lactose, respectively before and after transportation, while fresh milk before and after transportation were 4.18% and 4.31% of lactose. The data showed that there was no significant difference of lactose contain caused by the length transportation ($p>0.05$). Lactose on milk is affected by feed given to the animal, species and lactation time (Sugiyono *et al*., 2011). The amount of lactic acid bacteria also plays an important role in lactose contained in milk. (Buckle *et al*., 2008). Lactic acid bacteria can produce lactic acid from lactose and increase its population. Those conditions might change on milk quality particularly in lactose content. Estimated number of lactic acid bacteria in milk can be evaluated by measuring pH value and degree acidity of milk, low pH value and high acidity indicate a high amount of lactic acid bacteria. The cooling treatment that has been applied during transportation can inhibit bacterial growth so as not to affect the milk lactose content.

Total solids. Length transportation did not affected total solids of milk ($p>0.05$). Total solid of milk before and after transportation for frozen milk was 13.66% and 13.21%, while fresh milk was 11.33% dan 11.88%, respectively. According to Soeparno (2105), total solids of milk is affected by breed, feed nutrition, lactation, milking time and health factor. Mukhtar (2006) found that the percentage of water content was one of the factors that could affect to the up and down of total solid content on milk.

Solid non fat (SNF). Solid non fat (SNF) of fresh and frozen milk before and after transportation (Table 6) had no significant different ($p>0.05$). Solid non fat (SNF) before and after the transportation of frozen milk was 6.88% and 8.17%, while fresh milk was 7.60% and 7.84%, respectively. From the results, it can be obtained that the length of transportation was not affected by solid non fat (SNF) of milk. Mukhtar (2006) found that factors affected to the SNF are breed, repeatability, feed nutrition and weather. Salundik *et al*. (2011) explained the fat content, and total solids of milk also affect the SNF of milk, high-fat content and low total solid can lead to the lower SNF of milk.

Conclusions

Quality of fresh milk and frozen milk produced by Peternakan Sapi Terpadu (PESAT), North Sangatta were not affected by the length transportation for about 4 hours if evaluated by organoleptic test (color, aroma, and taste), density and freezing point of milk. However, total solids of milk changed after transportation. In addition, there were no significant effects on the physical and chemical quality of fresh and frozen milk during transportation.

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